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From the similar triangles PAB and PBD , we have $PB:DB=PA:AB$, or $PB:DB=h:a$. But $DB=\sqrt{(AD^2-AB^2)}=\sqrt{(4R^2-a^2)}$.

$$\therefore PB:\sqrt{(4R^2-a^2)}=h:a. \text{ Whence } PB=\frac{h\sqrt{(4R^2-a^2)}}{a}.$$

$$\therefore \frac{h^2(4R^2-a^2)}{a^2}=h(h+2R).$$

$$\therefore h=\frac{2Ra^2}{4R^2-2a^2}=\frac{Ra^2}{2R^2-a^2}=5.0062 \text{ miles.}$$

Also solved by G. B. M. ZERR, L. C. WALKER, H. C. WHITAKER, and J. SCHEFFER.

CALCULUS.

127. Proposed by J. A. CALDERHEAD, B.Sc., Professor of Mathematics, Curry University, Pittsburg, Pa.

Find the moment of inertia of a parallelogram about an axis perpendicular to its plane and passing through the intersection of its diagonals.

Solution by G. B. M. ZERR, A.M., Ph. D., The Temple College, Philadelphia, Pa.; J. SCHEFFER, A. M., Hagerstown, Md., and J. M. ARNOLD, Crompton, R. I.

Let the intersection of the diagonals be the origin; straight lines through the origin parallel to the sides, the axes; a , b the sides.

Then the required moment of inertia is

$$I=\rho\sin\beta\int_{-\frac{1}{2}a}^{\frac{1}{2}a}\int_{-\frac{1}{2}b}^{\frac{1}{2}b}[(x+y\cos\beta)^2+y^2\sin^2\beta]dxdy$$

where β is the acute angle of the parallelogram.

$$\therefore I=\rho\sin\beta\int_{-\frac{1}{2}a}^{\frac{1}{2}a}(bx^2+\frac{1}{2}b^2)dx=\frac{1}{2}\rho abs\sin\beta(a^2+b^2)=\frac{1}{2}m(a^2+b^2).$$

Also solved by W. J. GREENSTREET and L. C. WALKER.

128. Proposed by J. SCHEFFER, A. M., Hagerstown, Md.

The differential equation of a curve is $\frac{d^3y}{dx^3}+y=0$. Find its equation, there being the additional conditions that for $x=0$, $y=1$, that the tangent at the point $(0, 1)$ makes an angle of 45° with the axes, and finally that that point is a point of inflexion.

Solution by WILLIAM HOOVER, A. M., Ph. D., Professor of Mathematics and Astronomy, Ohio University, Athens, O.; and L. C. WALKER, A. M., Professor of Mathematics, Petaluma High School, Petaluma, Cal.

Using D for the operator d/dx , the given equation is

$$(D^3+1)y=0\dots\dots(1), \text{ or } (D^2-D+1)(D+1)y=0\dots\dots(2).$$

Integrating $(D+1)y=e^{kx}(A\cos\frac{\sqrt{3}}{2}x+B\sin\frac{\sqrt{3}}{2}x)\dots\dots(3).$

Differentiating this with respect to x ,

$$\frac{d^2y}{dx^2} + \frac{dy}{dx} = e^{kx} \left[\left(\frac{1}{2} \cos \frac{\sqrt{3}}{2}x - \frac{\sqrt{3}}{2} \sin \frac{\sqrt{3}}{2}x \right) A + \left(\frac{1}{2} \sin \frac{\sqrt{3}}{2}x + \frac{\sqrt{3}}{2} \cos \frac{\sqrt{3}}{2}x \right) B \right] \dots\dots(4).$$

When $x=0$, $y=1$, $dy/dx=1$, and (3) gives $A=2$.

When $x=0$, $D=1$, $D^2=0$, and (4) gives $B=0$.

\therefore (3) is $(D+1)y=2e^{kx}\cos\frac{\sqrt{3}}{2}x\dots\dots(5).$

Integrating (5), and noticing that when $x=0$, and $y=1$, the constant of integration is nought,

$$y=e^{kx}\left(\frac{1}{3}\sqrt{3}\sin\frac{\sqrt{3}}{2}x+\cos\frac{\sqrt{3}}{2}x\right)\dots\dots(6).$$

Also solved by G. B. M. ZERR and J. SCHEFFER.

MECHANICS.

128. Proposed by M. E. GRABER, A. B., Heidelberg University, Tiffin, Ohio.

A particle is placed on the convex side of a smooth ellipse and is acted upon by two forces, F and F' , towards the foci, and a force, F'' , towards the center. Find the position of equilibrium.

Solution by G. B. M. ZERR, A. M., Ph. D., The Temple College, Philadelphia, Pa.; and the PROPOSER.

Let C be the center of the ellipse, semi-axes a , b ; F_1 , F_2 , the foci; force $PF_1=F$, $PF_2=F'$, $PC=F''$; distance $PC=r$. Let fall the perpendiculars F_1G , CH , F_2K from the foci F_1 , F_2 , and the center C on the tangent at P .

Let $\angle PF_1G = \angle PF_2K = \theta$, $\angle PCH = \varphi$.

Then $F\sin\theta = F'\sin\theta + F''\sin\varphi$.

$$\therefore \frac{\sin\varphi}{\sin\theta} = \frac{F-F'}{F''} = n, \text{ suppose.}$$

$$F_2K = F_2P\cos\theta, F_1G = F_1P\cos\theta, CH = r\cos\varphi.$$

$$2CH = F_2K + F_1G = (F_2P + F_1P)\cos\theta = 2a\cos\theta.$$

$$\therefore r\cos\varphi = a\cos\theta.$$

$$F_2K \cdot F_1G = b^2 = F_2P \cdot F_1P \cos^2\theta = CM^2 \cos^2\theta = (a^2 + b^2 - r^2) \cos^2\theta.$$

$$\therefore \cos\theta = \frac{b}{\sqrt{a^2 + b^2 - r^2}}, \quad \sin\theta = \frac{\sqrt{a^2 - r^2}}{\sqrt{a^2 + b^2 - r^2}}.$$

